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# Naturalization of Java Podocarpus in Hawaii Rain Forest

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ABSTRACT: *Podocarpus cupressina* is naturalized in the rain forest near Hilo, Hawaii; reproduction has invaded both planted forest and undisturbed native forest. The possibility of using this tropical conifer for timber is suggested.

Java podocarpus (Podocarpus cupressina R. Br.[1]) is a dioecious gymnosperm native to a broad trans-equatorial region of the Western Pacific Ocean (fig. 1). It grows from almost sea level to nearly 10,000 feet elevation. Variable in habit, podocarpus is sometimes a large tree, sometimes a shrub. Wasscher[2] reported that its wood is used for furniture, building construction, masts, and carving. The Handbook of Coniferae[3] lists the tree as an important timber species in the Philippines. But Roberts[4] states that the tree is used only slightly because of its inaccessability.

## PLANTINGS AT PUU KAUKU

Ten podocarpus trees were planted in an arboretum in 1924 on the lower slopes of an ancient Mauna Kea cinder cone, Puu Kauku, near Hilo, Hawaii. The seed was from Gedeh, Java. Nine of the planted trees have survived; one was cut several years ago, but has produced two strong coppice shoots from the stump.

Elevation at the planting site is about 1,600 feet; annual precipitation is about 200 inches, with no regular dry period. Annual temperature averages about 70° F., and ranges from about 55° F. to about 90° F. Frost is unknown at this elevation.

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[1] *P. javanicus* Blume; *P. Horsfieldii* Wallich; *P. imbricatus* Blume; *Taxodium Horsfieldii* Knight; *Glyptostrobus Horsfieldii* Knight; *Nageia cupressina* Knight.

[2] Wasscher, J. The genus Podocarpus in the Netherlands Indies Blumea. 4(3): 359-481. 1941.

[3] Dallimore, W., and Jackson, A. B. A handbook of coniferae. 686 pp., illus. London: Edward Arnold. 1961.

[4] Personal communication with E. V. Roberts, Forestry Advisor, U. S. Agency for International Development, Philippines, Jan. 17, 1964.

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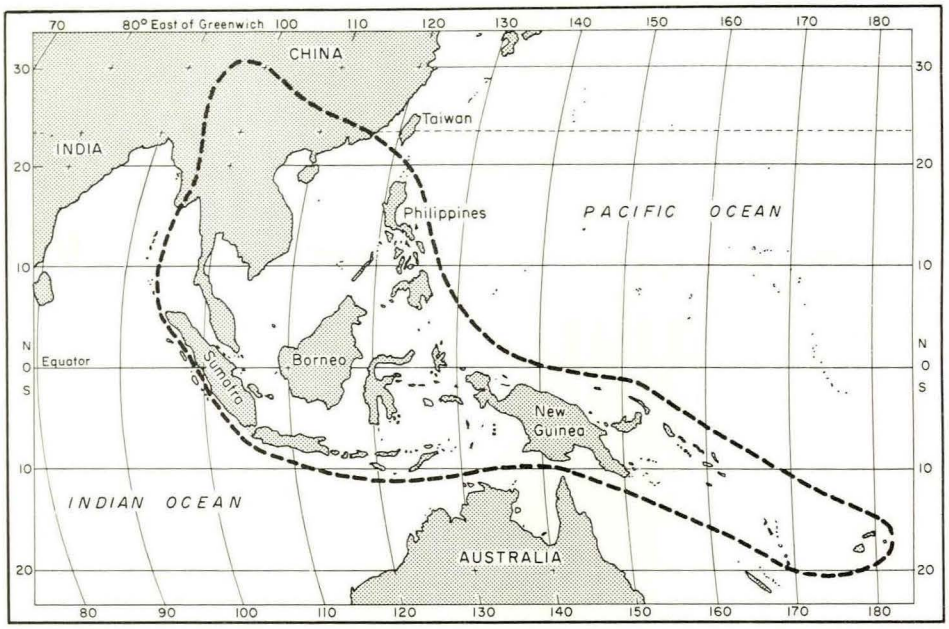


Figure 1.--Natural range of Java Podocarpus (*Podocarpus cupressina* R. Br.).

The planting is of particular interest partly because podocarpus has possible value in Hawaii as a timber species, and partly because podocarpus seedlings have invaded the surrounding planted and native forests. A tree 4 inches in diameter at breast height (d. b. h.) was found about 1,600 feet from the nearest seed-bearing tree. Seedlings 4 to 6 inches d. b. h. are common within about 1,000 feet of seed trees; in some places they form a heavy understory beneath planted robusta eucalyptus (Eucalyptus robusta Sm.) (fig. 2).

## DISSEMINATION OF SEEDS

The false mynah bird (Acridotheres tristes L.) is believed to be responsible for dissemination of the podocarpus seed. An introduced species, it makes up a large local population. Apparently birds carry seed from the parent tree, and eat the fleshy receptacle subtending the seed (fig. 3). This receptacle is about 1/4-inch long, sweet tasting, and scarlet when ripe. The lack of other probable agents strengthens the belief that birds are responsible for seed dissemination. Furthermore, podocarpus seedlings are often found growing within 2 feet of the bases of larger trees of other species, usually well removed from the nearest podocarpus seed tree. The birds appear to use these larger trees as perch trees after they pick a ripe fruit from a podocarp. The large (about 3/16-inch diameter) hard-coated seed is discarded and falls near the perch tree after the bird eats the receptacle.

Figure 2.--Advanced natural reproduction of *Podocarpus cupressina* established under large *Eucalyptus robusta*, at Puu Kauku, near Hilo, Hawaii.

Figure 3.--Twig of *Podocarpus cupressina* shows fleshy receptacle subtending seed. This scarlet, sweet-tasting receptacle attracts birds.

Figure 4.--Pole-timber sized *Podocarpus cupressina* tree in a dense stand of advanced reproduction at Puu Kauku near Hilo, Hawaii. This tree was 9.5 inches d.b.h.

Podocarpus produces seeds the year round. Foot-square reproduction quadrats at the crown edges of the original planting averaged 25 seedlings per quadrat, ranging in height from less than 1 inch to 3 feet. Near the trees the ground was littered with many fresh seeds. Many seeds had been gnawed open--the toothmarks suggesting mice or rats. These animals are probably not responsible for seed dissemination. Gnawed seed were found only in the immediate vicinity of the seed trees. And distances of many seedlings from the nearest seed tree far exceed the limited ranges of small rodents.

## CONDITION OF PLANTINGS IN 1964

In 1964, the 40-year-old planted podocarpus trees ranged in height from 40 to 80 feet and in d.b.h. from 7 to 22 inches. Two 30-foot coppice shoots grew from the 16-inch diameter stump of the cut tree. Five of the trees are female and three are male. The sex of the cut tree could not be determined.

Trees in the original planting are excessively branched and of poor form. Lower branches, several inches in diameter, remain alive on several trees. The trees were planted on an abandoned sugar cane field and probably grew as open-grown trees for the first several years. Other species, including robusta eucalyptus , have also failed to make normal growth on this site.

In contrast, robusta eucalyptus planted earlier on the nearby Hilo Forest Reserve without an agricultural history are large and of good form. Podocarpus reproduction under this stand is dense and well-formed. Branches are small and self-prune early (fig. 4). A 1/20-acre plot there was inventoried and trees measured by 5-foot height classes and half-inch diameter classes. Heights ranged up to 50 feet and diameters ranged from less than 1/2 inch up to 9-1/2 inches. Number of trees in each class was as follows:

| Height class (5-foot classes) | Number of trees |
|---|---|
| Less than 5 | 2 |
| 5 | 2 |
| 10 | 4 |
| 15 | 2 |
| 20 | 7 |
| 25 | 3 |
| 30 | 1 |
| 35 | 3 |
| 40 | 0 |
| 45 | 2 |
| 50 | 1 |

Members of the Hawaii Forestry Division reported that podocarpus regeneration in the Puu Kauku area was first noticed during the period 1940-1945, indicating that the planted trees began bearing viable seed at age 16-21 years. The older reproduction should begin seeding soon

and probably will extend the podocarpus invasion quite rapidly. In theory, the area of extension depends on the radius of the invading population. Except on the seaward side, where sugar cane is grown, there is little to prevent the realization of the theoretical potential extension. Conditions quite similar to those of the presently invaded area exist over thousands of acres of rain forest.

LeBarron[5] has suggested that plantings such as that at Puu Kauku and other more shade-tolerant and better adapted naturalized species may become a serious problem in the management of less tolerant planted forests. This is undoubtedly true. Hundreds of species of trees and shrubs have been introduced into Hawaii; some of them are naturalized and present problems in various types of land use. Some species, such as silk-oak (Grevillea robusta A. Cunn.), show a potential as needed and valuable saw-timber.[6]

## APPRAISAL OF OTHER PLANTATIONS

In addition to the Puu Kauku planting, four other podocarp plantations on the island of Hawaii were appraised. These sites range up to 5,000 feet in elevation and are widely separated in different districts on the island. In all but one, the podocarpus trees were found to be in good condition and showing signs of active growth. In one planting at 3,500 feet elevation, the trees were producing seed, but no reproduction was found. As the trees are only 15 to 20 feet in height, it is possible that they have not been producing seed long enough for reproduction to become established. Where podocarpus was found to be in poor condition, it was almost entirely covered by banana poka vines (Passiflora mollissima (HBK) Bailey).

The introduced vegetation of Hawaii has not, in general, formed even semi-stable communities, but is extremely dynamic. The sorting-out and grouping of species is occuring constantly and changing as naturalized species extend their distribution. Some, however, have become established to the extent that they probably will be important components in future Hawaiian forests. Podocarpus appears to be one of these within one generation of its introduction. Efforts should be made to determine whether this species will become a problem or whether land managers can take advantage of its ability to become established under an existing forest canopy. Perhaps this well adapted tropical conifer can be used to reduce, in part, the large amount of softwood lumber that Hawaii imports each year.

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[5]LeBarron, R.K. Eucalypts in Hawaii: a survey of practices and research programs. U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Misc. Paper 64, 24 pp., illus. 1962.

[6]Nelson, R.E. Silk-oak in Hawaii...Pest or potential timber? U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Misc. Paper 47, 5 pp., illus. 1960.

The Author

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